Operations Manual

Battery Monitoring System Model BMS100

Distributed by:

SOLAR PANELS PLUS

P: (757) 549-1494

AQUION ENERGY

AQ-OP-00008_B

Table of Contents

1. General Information

1.1 About This Manual

This manual is intended to provide technical information and safe practices regarding receiving, installing, operating, and servicing the Aquion Energy BMS100 Battery Monitoring System. For complete safety information, refer to the Safety Data Sheet (SDS) included with your product shipment.

NOTICE: Failure to follow the instructions in this document could result in fire, electric shock, and/or other injury or damage.

1.2 Disclaimers

Estimated performance characteristics are based on testing conducted by Aquion Energy. Performance may vary depending on use conditions and application. Aquion Energy makes no warranty, explicit or implied, with this technical information. Contents are subject to change without notice.

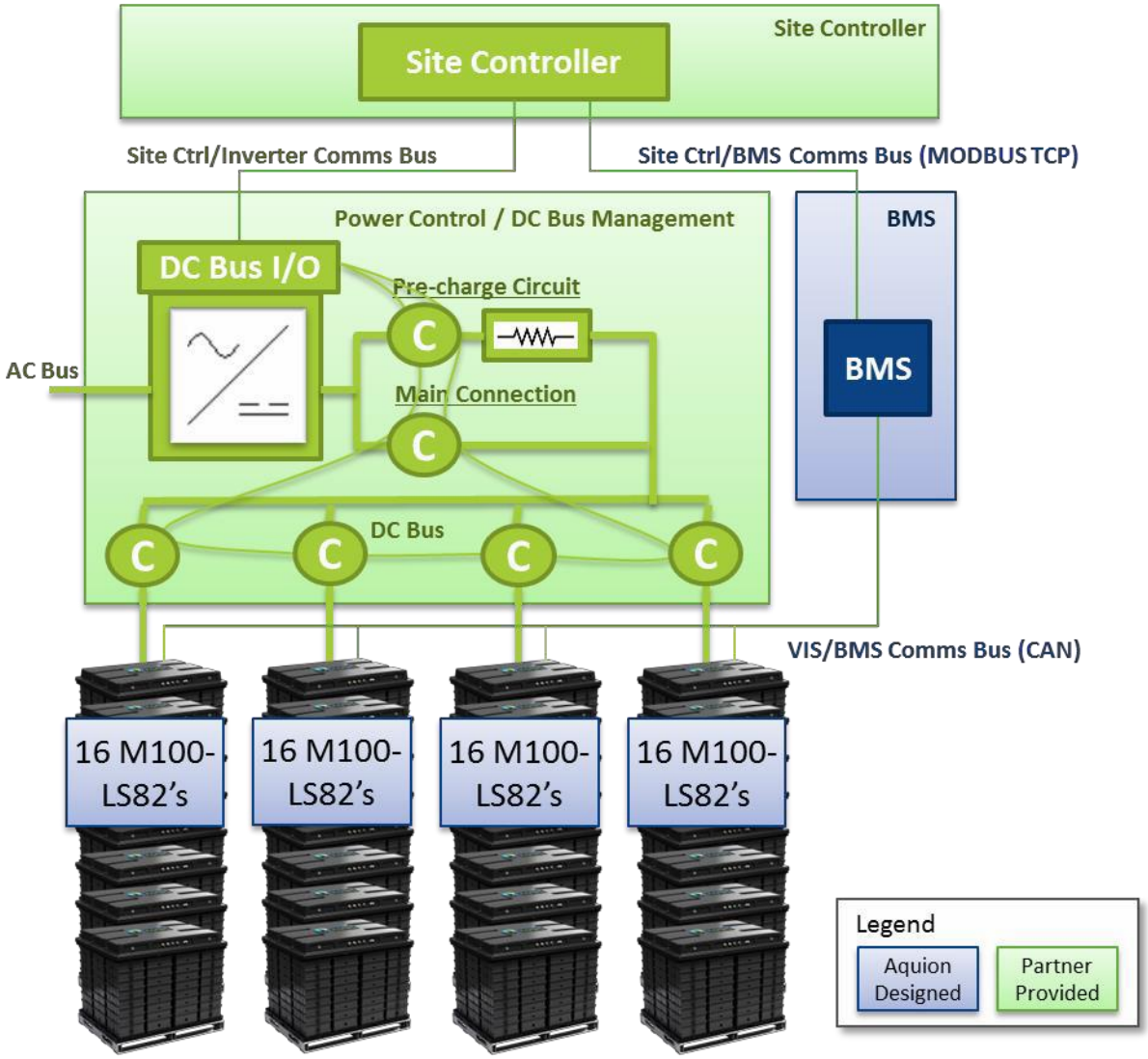
1.3 Contact Information

Authorized Distributor
Solar Panels Plus, LLC.
2133 Smith Avenue
Chesapeake, VA 23320
(757) 549-1494
www.solarpanelsplus.com

2. Product Information

2.1 BMS100 Battery Monitoring System

The BMS100 Battery Monitoring System (hereafter "BMS100") is used to collect data from all Battery Modules in a string, store the data, and relay that data to the site controller.



3. Safety Information

3.1 General Safety Information

- The BMS100 can communicate with up to 16 Battery Modules in a string.
- The BMS100 can support up to 4 strings of Battery Modules, with each string composed of no more than 16 Battery Modules.
- Never connect more than 16 Modules in a string. Doing so may damage the BMS100.
- Never connect the CANBUS with the BMS100 powered on. Doing so may damage the BMS100 and Module VIS boards.

4. Receipt of Equipment

4.1 Delivery Inspection

- Immediately upon delivery, inspect all hard goods for signs of damage during transit. This may be evidenced by damaged enclosures or connectors. Thoroughly document all instances of product damage and make a claim with the carrier as soon as possible. Contact Aquion Energy for further support.

The inside of the BMS should look like this.

4.2 Actions

- If, upon delivery, equipment appears to be damaged, do not accept the shipment.
- If you have accepted shipment and equipment in the shipment appears to be damaged, please contact your appropriate support representative. For technical support contact information, please see Section 11, Technical Support and Troubleshooting.

5. Service Conditions

5.1 Environmental Specifications

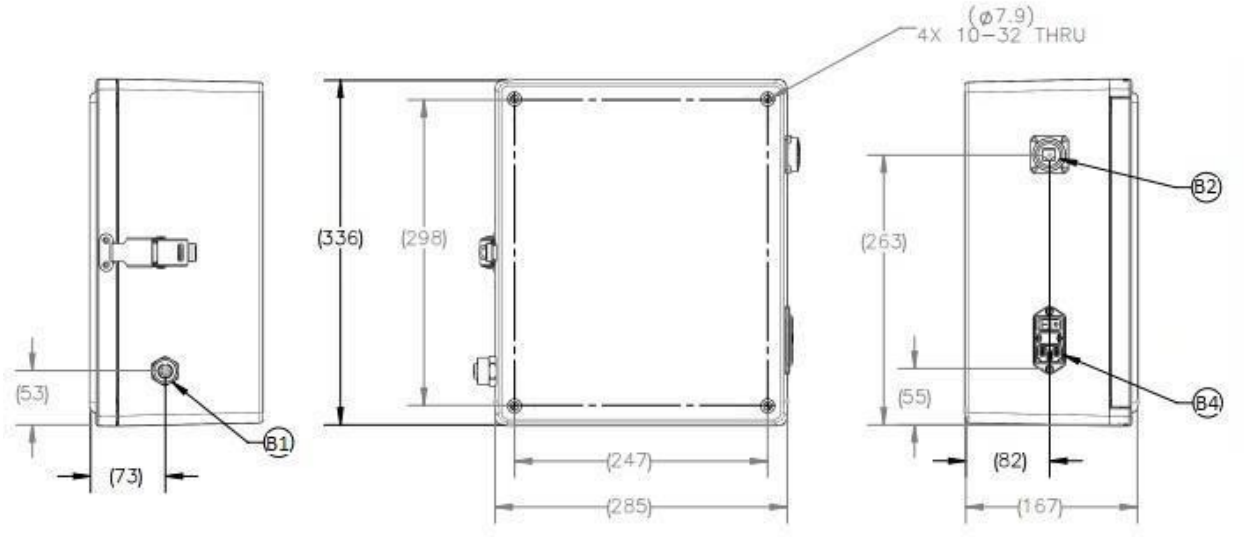
- Environmental specifications must be followed to ensure maximum performance of AHI batteries.
- Units are designed to be stored/operated in a dry, clean environment with protection from sunlight and water ingress. Material degradation can result from direct exposure to sunlight.

5.2 Temperature Limits

- The BMS should be both stored and operated in the same environment as the Aquion batteries.

6. Installation Procedure

6.1 BMS Electrical Interfaces and Connections



B1 CAN OUT

P/N: Amphenol SineCo MN54PD02M005

PIN #	NAME	WIRE COLOR	DESCRIPTION
1	Drain	Shield	CAN ground
2	V+	Red	+24 V Board Power
3	V-	Black	Return Board Power
4	CAN_H	White	CAN Bus High
5	CAN_L	Blue	CAN Bus Low

B2 MODBUS/TCP Connector

P/N: Mouser 523-RJF21B

PIN #	NAME	WIRE COLOR	DESCRIPTION
1	TX_D1+	White/Green	Tx Data+
2	TX_D1-	Green	Tx Data-
3	RX_D2+	White/Orange	Rx Data+
4	Bi_D3+	Blue	Bi-directional Data+
5	Bi_D3-	White/Blue	Bi-directional Data+
6	RX_D2-	Orange	Rx Data-
7	Bi_D4+	White/Brown	Bi-directional Data+
8	Bi-D4-	Brown	Bi-directional Data-

B4 120VAC Power Input

P/N: Mouser 693-DD12.9321.1111

PIN #	NAME	WIRE COLOR
L	Line	Black
N	Neutral	White
G	Ground	Green

6.2 CAN Connector Cable

P/N: MN57B4BD02Mxxx (xxx - cable length in decimeters)

This cable connects between the BMS100 B1 CAN OUT and the M100 J5 CAN IN.

6.3 MODBUS/TCP

P/N: Mouser 523-RJF21B

This port is used to connect the BMS100 to the site controller network via a standard cat5 ethernet cable.

6.4 Input Power Port

P/N: Mouser 693-DD12.9321.1111

The input power comes from a standard IEC cable. There is a replaceable fuse between the input feed and the power switch. The BMS100 must have constant supply voltage to ensure functionality.

6.5 CAN Out Port

P/N: Amphenol Sineco MN54PD02M005

This port connects between the BMS100 to the M100 Modules.

7. Operation

7.1 BMS100 Setup

The BMS100 is designed for simple hardware installation, software updating, and logging control. More advanced operations are detailed in Section 7.2, BMS100 Testing and Analysis.

7.1.1 Hardware Installation

1.) Connect the male side of the DeviceNet cable to the CAN port. The female side of the DeviceNet cable will connect to the M100 J5 CAN port. Make sure the DeviceNet cable string is properly connected to the M100.

2.) Connect the MODBUS/TCP port to the Site Controller Network.
3.) Connect the 120 Vac Input cable and turn the switch on.

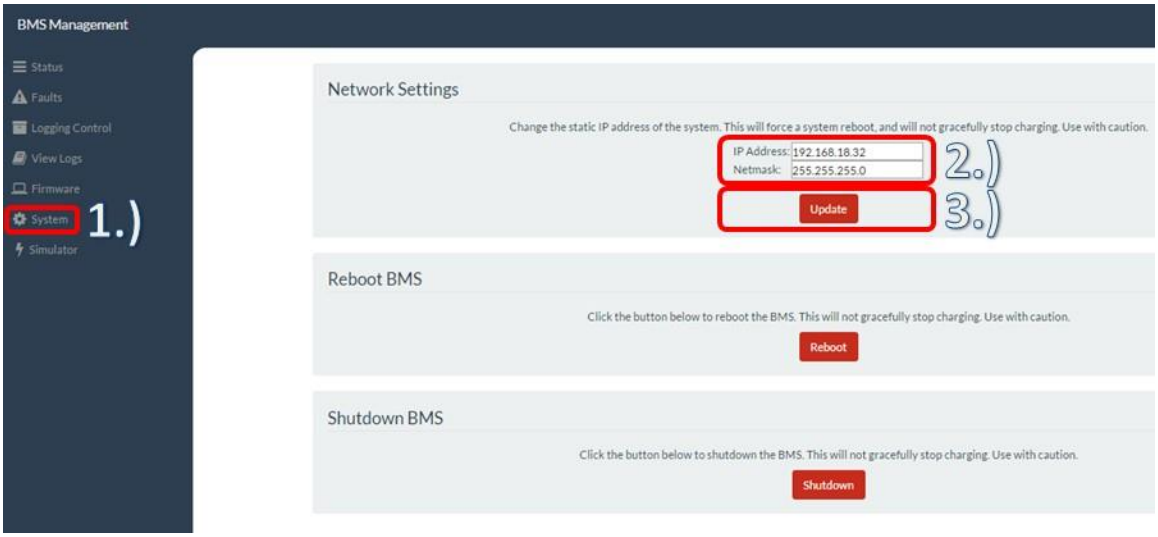
7.1.2 Web Page Operations

7.1.2.1 Logging In

To log into the BMS web interface, first find the unit's IP address written on the outside of the unit, next to the ethernet port. Then, in a web browser, navigate to the IP address followed by "/bms" to log into the web interface.

7.1.2.2 Changing the IP Address

Once logged in, you can generate a new IP address for your BMS unit.



1.) Click the “System” tab.

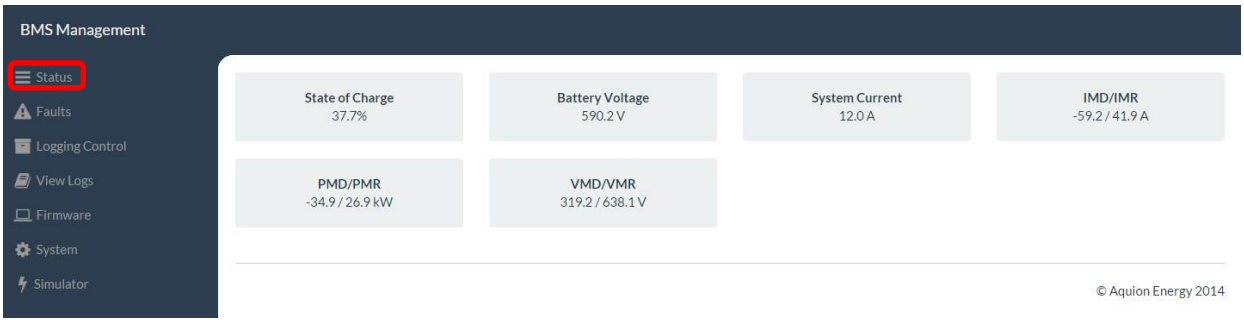
2.) Input the new IP address and netmask.

3.) Click “Update.”

The system will change the IP address and reboot to allow the change to take effect.

7.1.2.3 Status Display

The “Status Display” displays the real-time key systems values updated at .5Hz. These values are State of Charge, System Output Voltage, System Input Current, and E-STOP State.



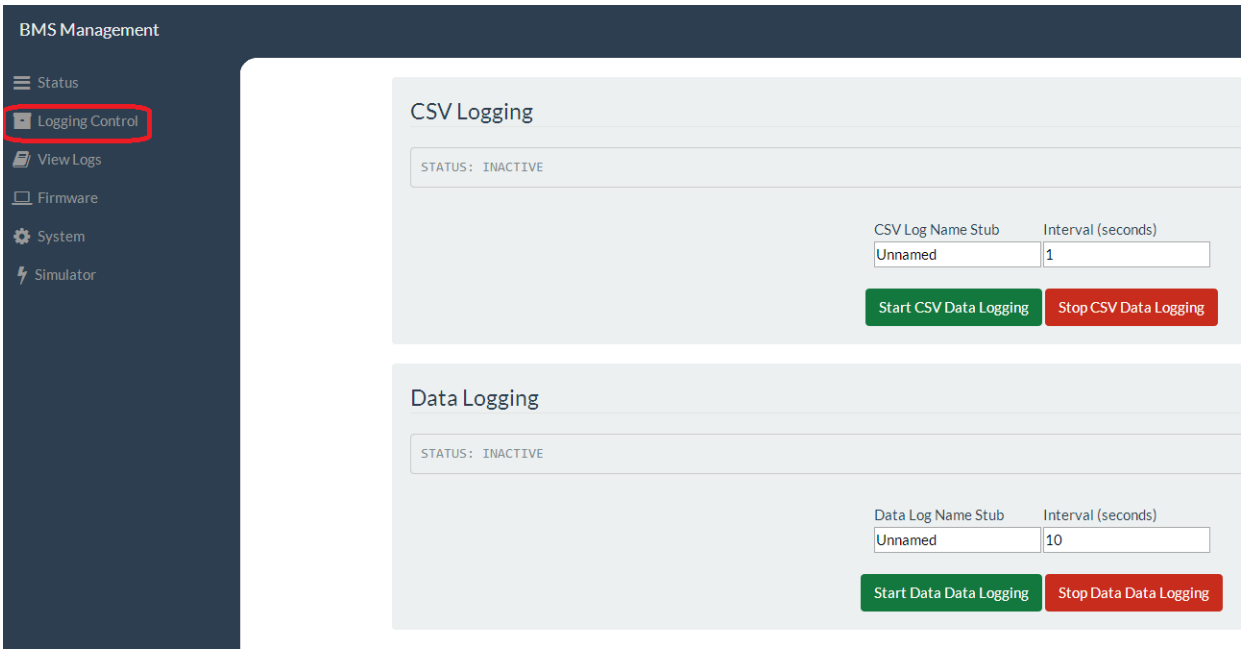
7.1.2.4 Faults

The “Faults” screen will display any faults present in the system. A green indicator signifies normal functioning, and a red indicator signals a fault. To reset the “Faults” report, you must click “Reset All Faults.”

7.1.2.5 Logging Control

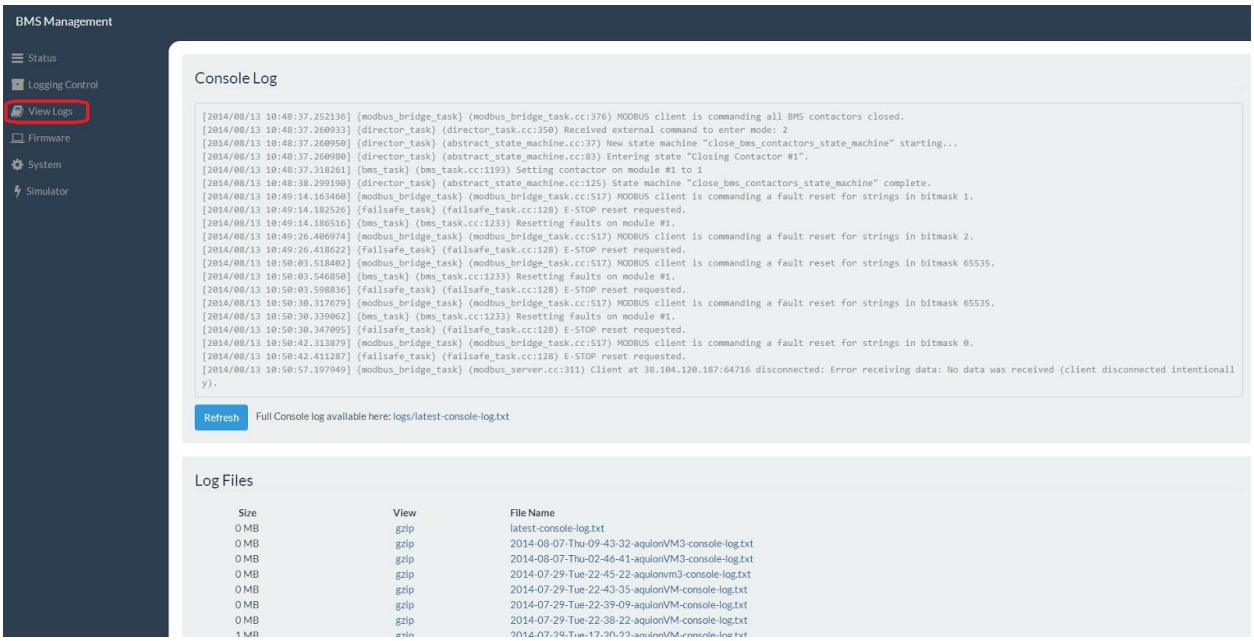
The “Logging Control” tab allows the user to create comma-separated value (CSV) and binary logs. The CSV logs are easily read by Microsoft Excel. These logs are recorded once a second. The binary logs are compressed, high-resolution files containing detailed information on the performance of the system. These logs are recorded once every 10 seconds. Appendix C details what is contained in the CSV and high-resolution logs.

The BMS hard drive has less than 100 GB of available storage, and the high-resolution log files take up about 70 MB/day. This should allow you to store up to 4 years’ worth of high-resolution log files.



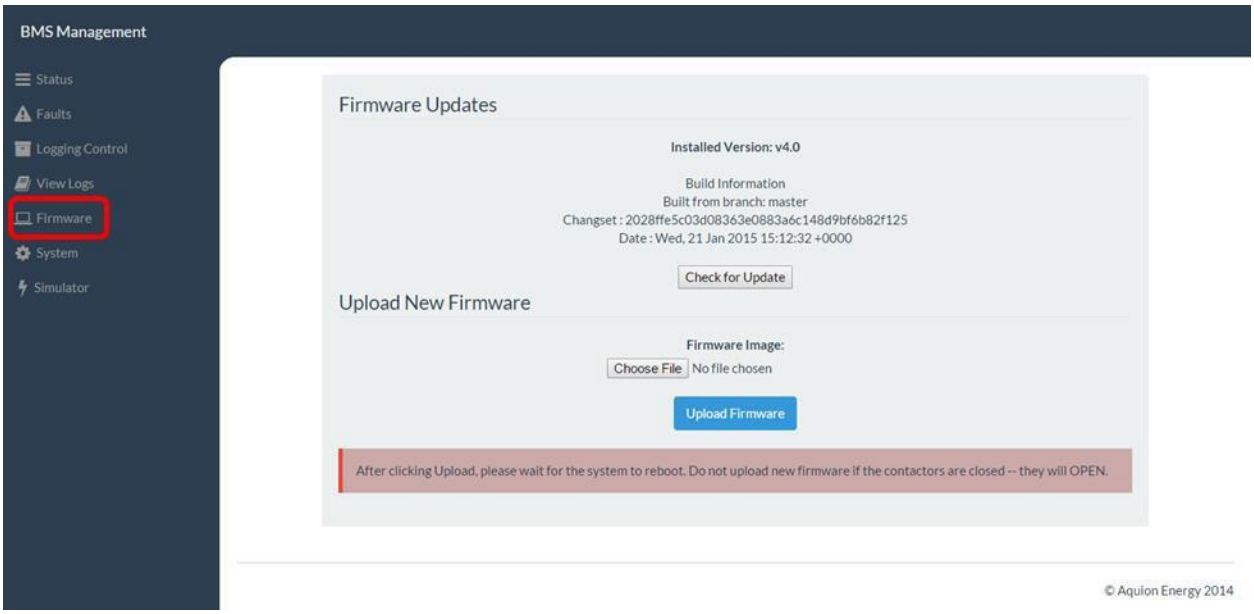
7.1.2.6 View Logs

The “View Logs” tab allows the user to see all of the operations that have occurred on the BMS.



7.1.2.7 Firmware Update

As new software updates are released, Aquion will provide notification to the customer, and the BMS100 will need to be updated. The “Firmware” tab allows the user to upload the latest firmware.

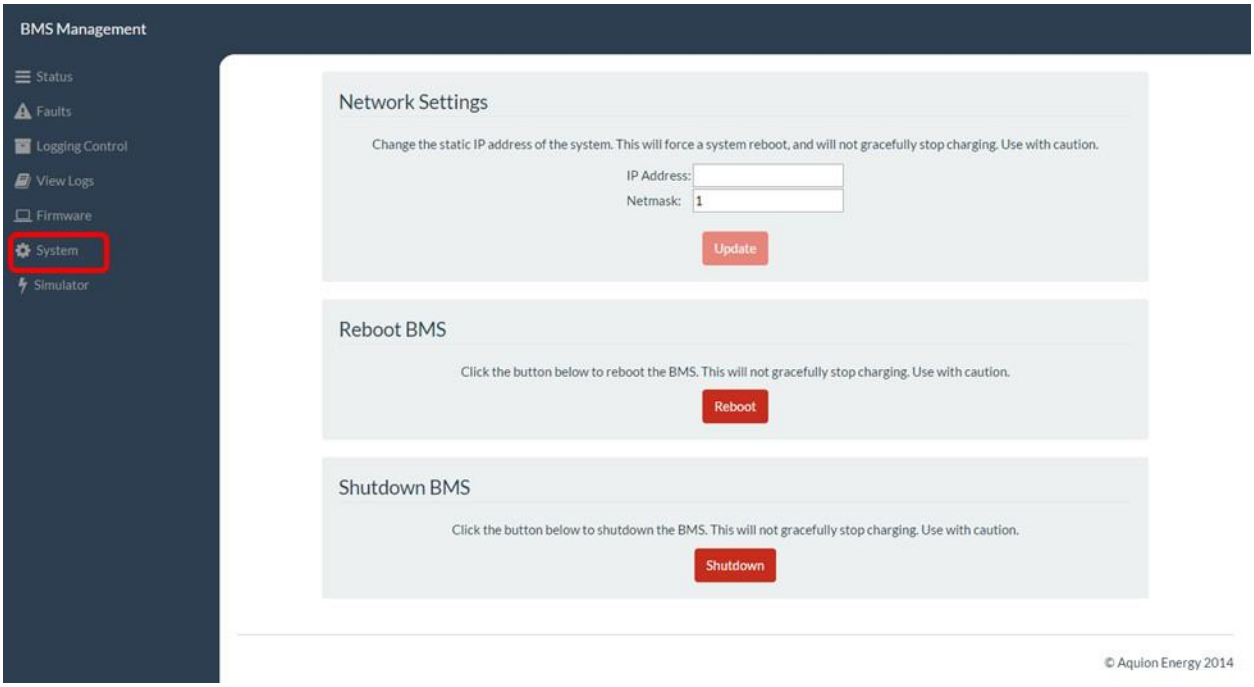


1.) Click “Choose File.” Browse to find the *.pkg file from Aquion Energy.

2.) Click “Upload Firmware.” The system will update the firmware and reboot the BMS.

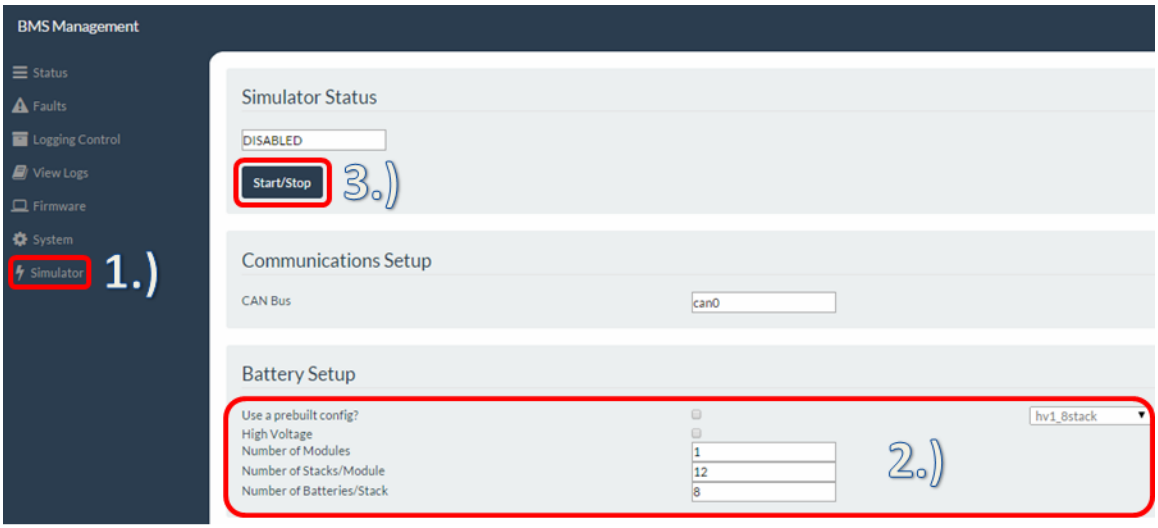
7.1.2.8 System Shutdown

The BMS100 should be shut down and restarted via the “System” tab. This will prevent file system corruption that may occur if the BMS100 experiences power loss.



7.1.2.9 Simulator

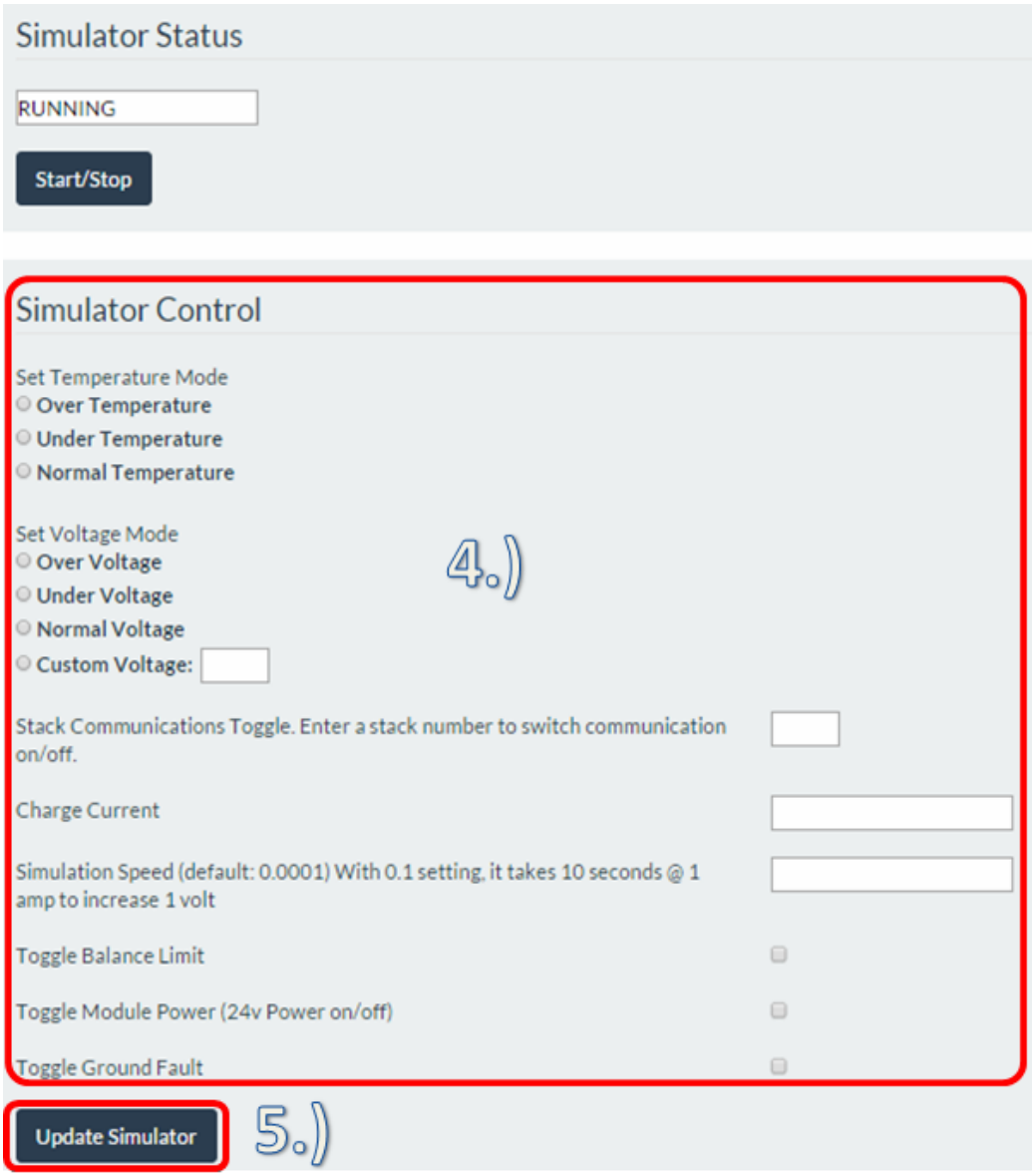
The simulator is used to simulate the communication of VIS boards and MODBUS. It allows the user to try the controls protocol without having an M100 module connected.



1.) Click the “Simulator” tab to bring up the simulator controls.

2.) Either input your own configuration or click the “Use a prebuilt config?” checkbox.

3.) Clicking the “Start/Stop” button will start the simulator and initiate MODBUS messaging.



4.) Select an operation to perform.

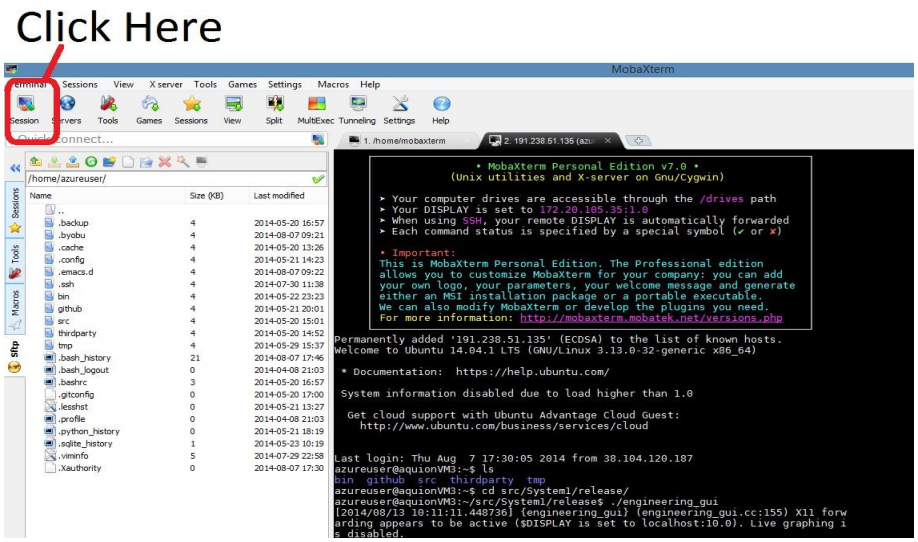
5.) Click “Update Simulator” to initiate the operation.

7.2 BMS100 Testing and Analysis

The BMS100 comes pre-loaded with the Engineering_GUI designed to aid in the testing and analysis of the BMS100 and M100 Battery Module performance.

7.2.1 Engineering_GUI Start-up Procedure

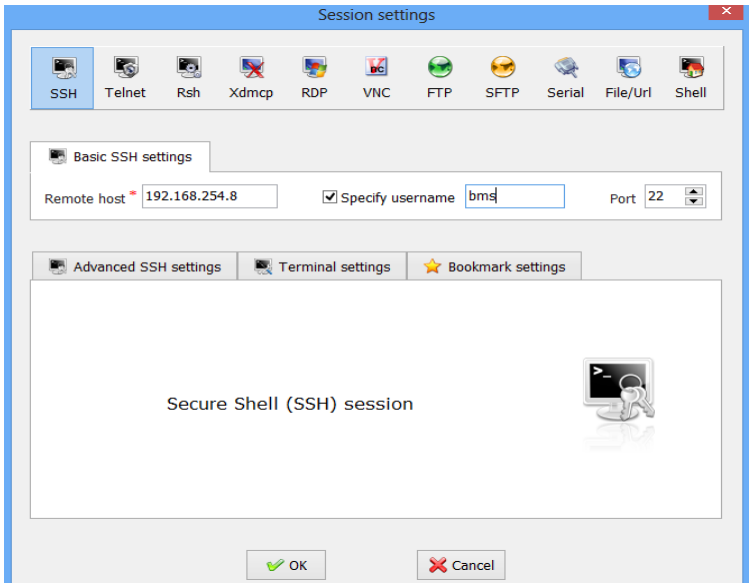
1.) SSH into the BMS100 via the Site Controller Network using MobaXterm freeware. MobaXterm freeware can be downloaded at http://mobaxterm.mobatek.net/download-home-edition.html.



2.) Start a New Session

Under Basic SSH Settings, enter:

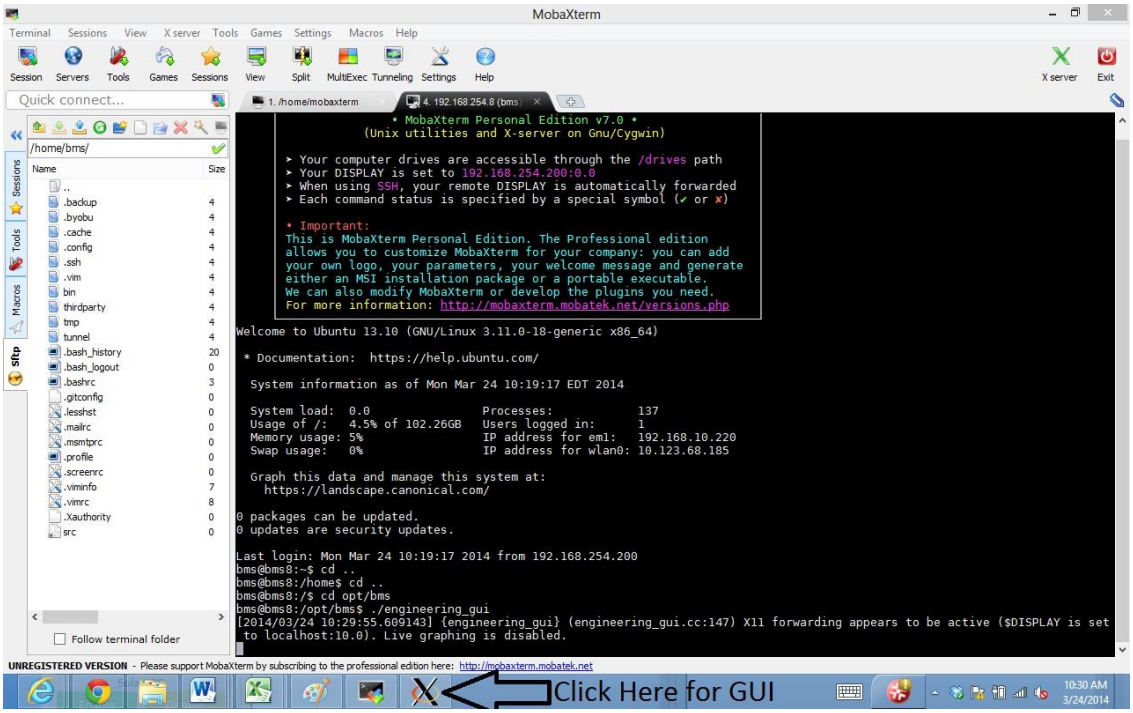
- Host Name: IP Address of the BMS100 unit (Found on outside of box next to ethernet port or set by customer DHCP server)
- Username: bms
- Port: 22 (SSH sessions are always done through Port 22)



3.) Click OK

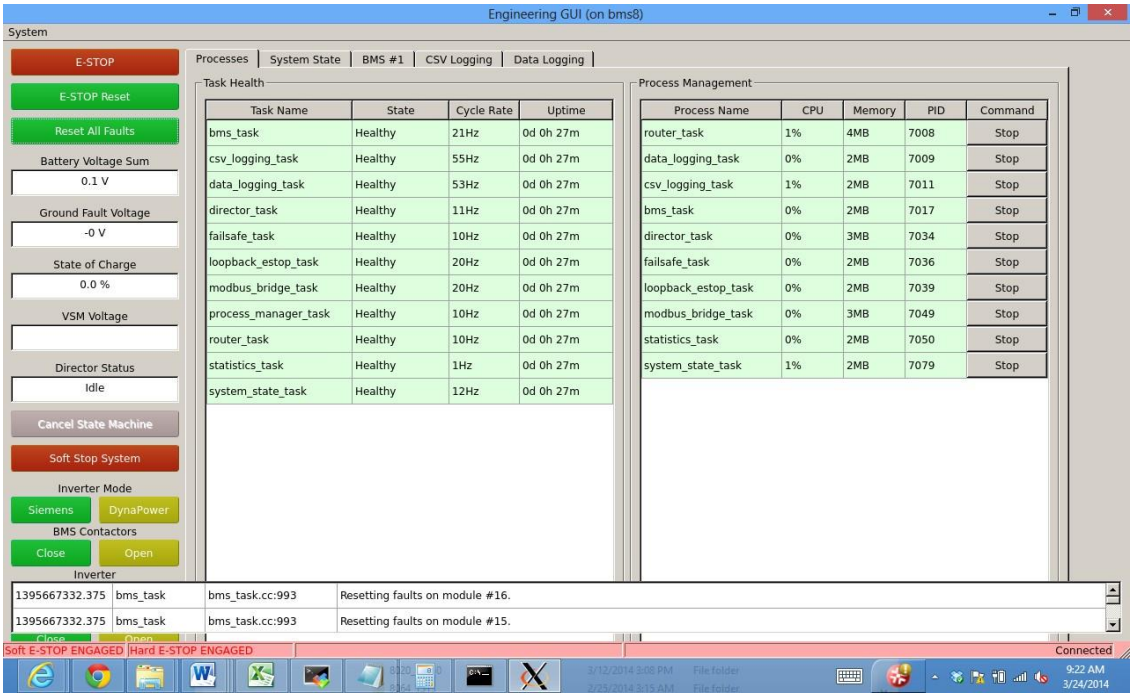
- Password: voltage
- To change the password, type "passwd" and follow instructions to change the password.

4.) Type "./engineering_gui"

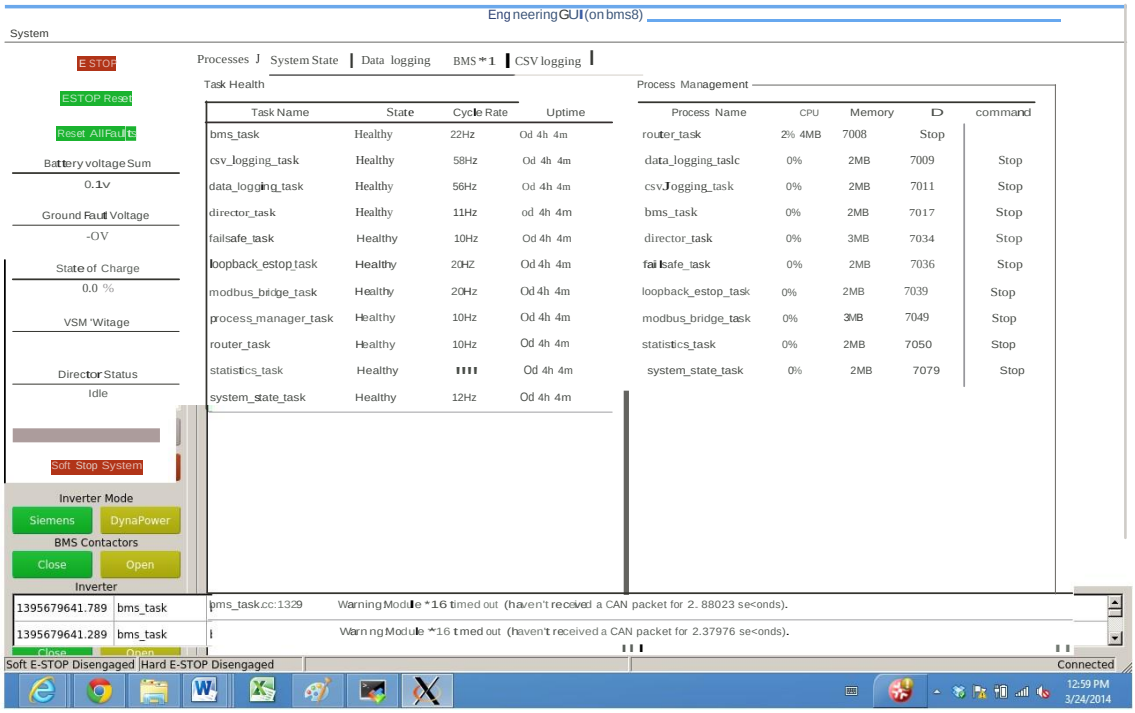


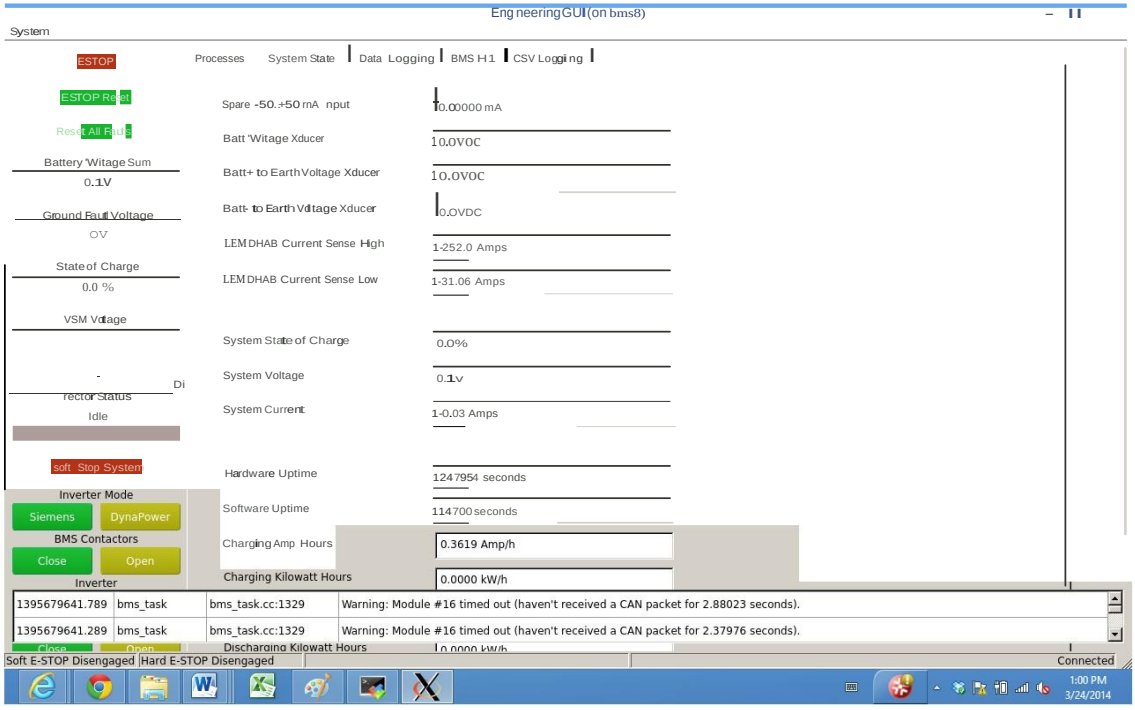
5.) Click the X on the taskbar to bring up the Engineering GUI

6.) If everything is working correctly, all states will show as “Healthy.” If there is a problem with the CAN network or VIS boards, Task Name “bms_task” will not show as “Healthy.”

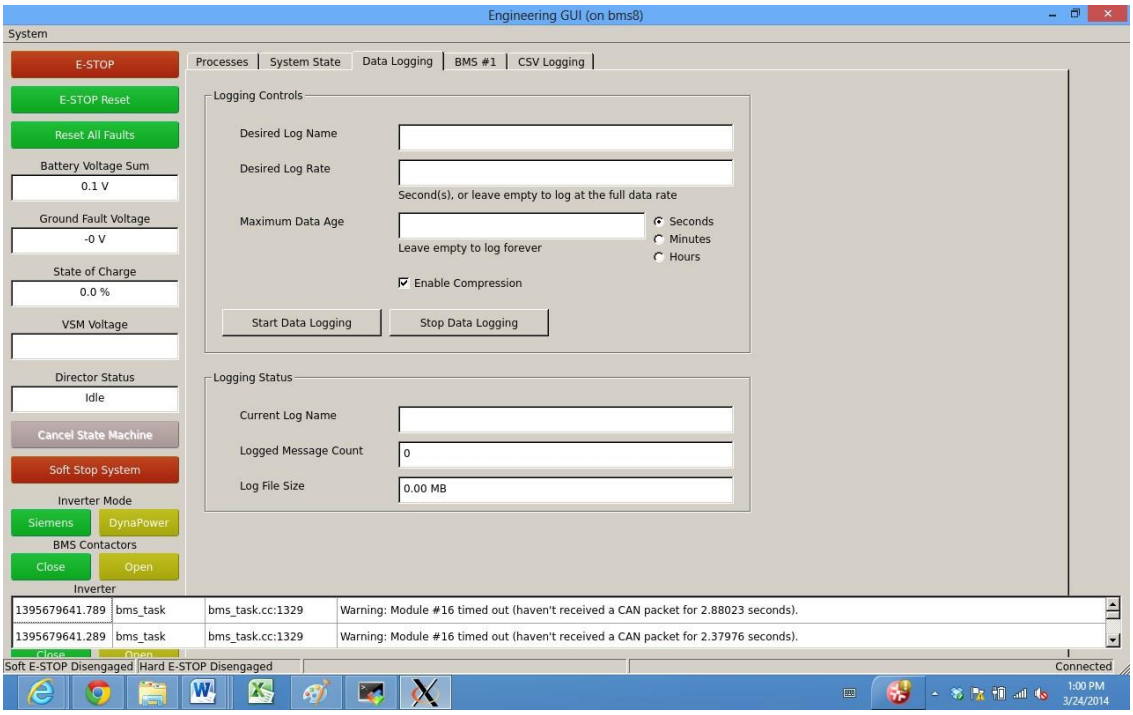


7.) It is not recommended to manually stop or start tasks.

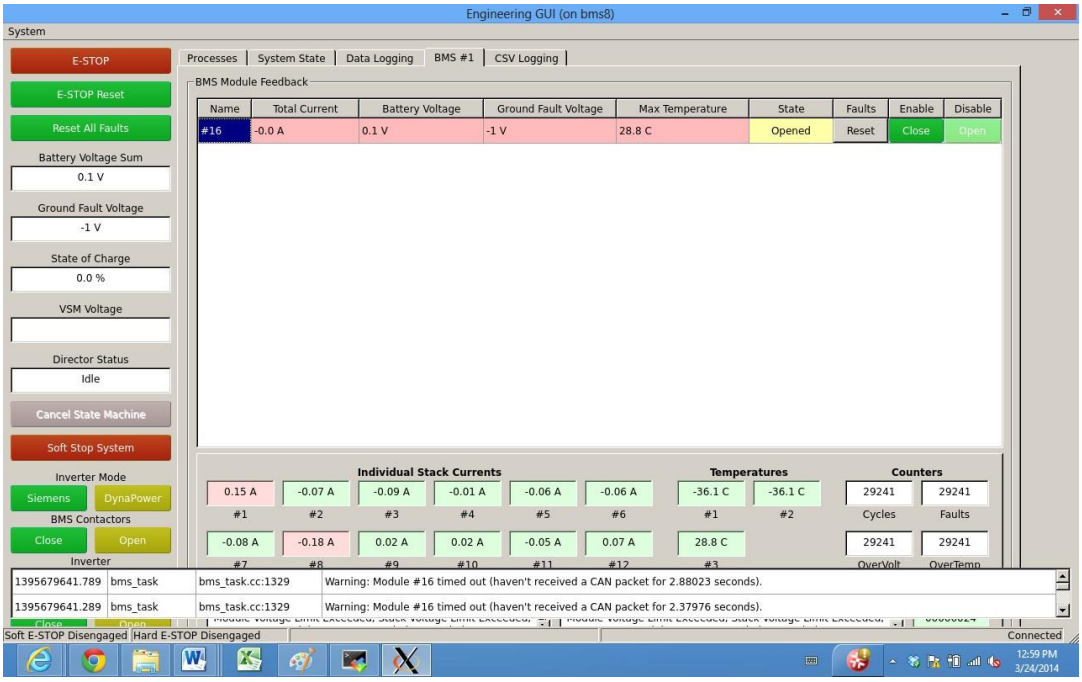




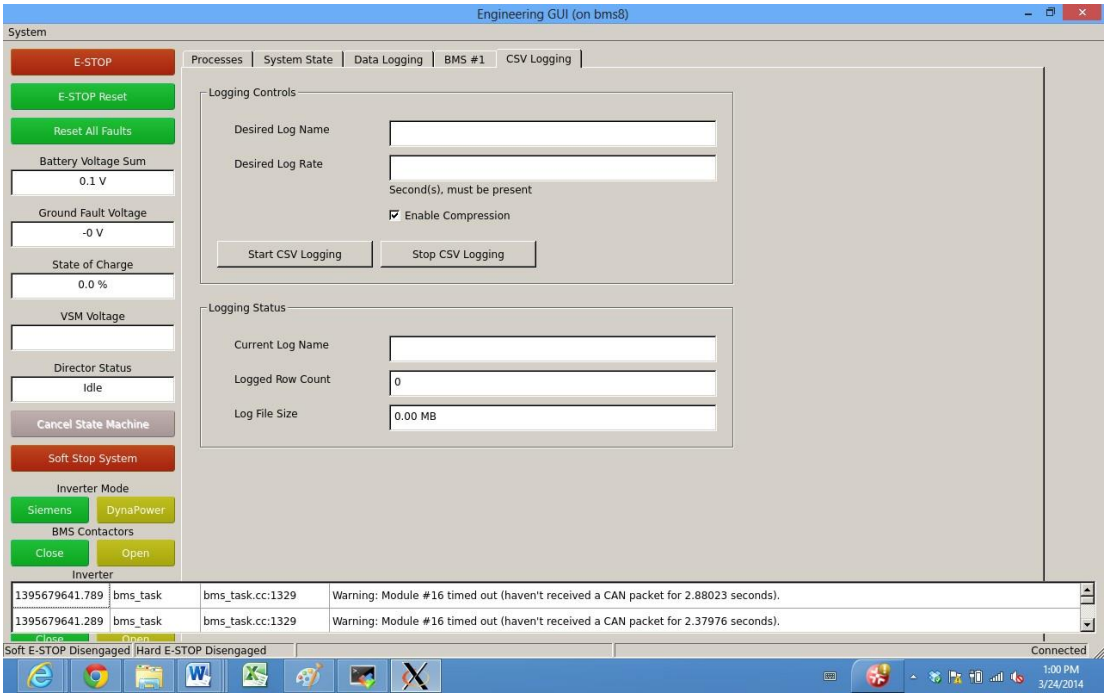
The “Data Logging” tab allows the user to create a log file to save all sensor data and calculations.



The “BMS #1” tab allows the user to select individual modules and view each one’s discrete state, voltage, current, and temperature.



The “CSV Logging” tab is similar to the “Data Logging” tab, but only the predetermined sense data will be saved instead of all data. The data will also be saved in CSV format so it can easily be read by Microsoft Excel. The contents of this file are detailed in Appendix C.



8. Storage

The BMS100 can be safely stored between -10°C and 40°C without significant performance degradation. The BMS100 should always be protected against water.

9. Commissioning

- Before commissioning, the system should be inspected for mechanical damage, and the M100 modules connecting to the BMS100 should be in full working order. See the M100 Battery Module Operations Manual for proper installation.
- Aquion recommends that personnel experienced with the operation of power electronics connect the BMS100 to the CANBUS and MODBUS/TCP, and that such operation should be conducted with the power off.

10. Components

Part Name	Ordering Code	Description
NUC Computer	Macsales.com (P/N: 9780486)	Intel NUC D54250WYK
Enclosure	McMaster (P/N: 7812K23)	16”x16”x6” enclosure
Fuse	McMaster (P/N: 6978K734)	fuse 10 A, 250 V
Panel	McMaster (P/N: 7812K63)	panel for enclosure
DIN Rail	McMaster (P/N: 8961K15)	DIN rail, 11.5”
Adapter	Monoprice (P/N: 9466)	ethernet to USB adapter
Power Supply	Mouser (P/N: 709-SDR75-24)	24 Vdc 75 W power supply
AC Power Module	Mouser (P/N: 693-DD12.9321.1111)	AC power input module
Insulation Cover	Mouser (P/N: 693-0859.0076)	protector for AC input
Fusedrawer	Mouser (P/N: 693-4301.1401)	fuse holder for input AC
RJ45 Connector	Mouser (P/N: 523-RJF21B)	RJ45 pass-through connector
Connector Cap	Mouser (P/N: 523RJFC2B)	cap for RJ45 pass-through
Computer Memory	Newegg (P/N: N82E16820233588)	Corsair Vengeance Performance 8GB
Hard Drive	Newegg (P/N: N82E16820167144)	mSATA 120GB SATA MLC Internal Solid State Drive
USB-CAN Adapter	Phytools (P/N: SYS-3204003)	SYSTEC USB-CANmodul2 adapter
Panel Mount Receptacle	Amphenol Sinco (P/N: MN54PD02M005)	panel mount DeviceNet receptacle 1 meter

11. Technical Support and Troubleshooting

For technical support and troubleshooting, contact your dealer or authorized distributor.

Appendix A: Frequently Asked Questions

What should I do if the bms_task is displayed as "unhealthy"?

This is usually caused by a failure of the BMS to communicate with the VIS boards. Check to make sure the VIS boards are powered up and connected properly.

What should I do if the modbus_bridge_task is displayed as "unhealthy"?

This is usually caused by a failure of the BMS to set up the MODBUS/TCP bridge to the site control. Check your system firewall to ensure it is not blocking IP permissions.

What should I do if the site controller is connected and set up as instructed, but it is still not communicating with the site controller?

Check your system firewall to ensure it is not blocking the port that the BMS uses to communicate. The BMS communicates on port 502.

Appendix B: Glossary of Battery Terminology

BMS – The BMS parses data from the VIS boards and processes it. The processed data is then stored locally and can be relayed to a site controller on request via the MODBUS/TCP port.

CAN – Protocol used to communicate between the M100 VIS boards and BMS.

M100 – Palletized battery system containing 12 S-line Battery Stacks.

MODBUS/TCP – Protocol used to communicate between the BMS and site controller.

Open Circuit Voltage (OCV) – Potential between positive and negative terminal with no load applied.

State of Charge (SOC) – Represents present battery capacity as a percentage of rated capacity. SOC is essentially the gas gauge of the battery from 0%–100%.

State of Health (SOH) – Represents the present capacity of the Module as a percentage of the nameplate capacity.

VIS board – The VIS board measures the voltage, current, and temperature of a Battery Module and relays that data to the BMS.

Appendix C: BMS Data

C.1 Binary Logs

Binary logs are meant to store all of the data the BMS measures and calculates. Because these high-resolution data files can become large, they are meant to be stored for small time periods only.

C.1.1 System Level

Name	Description	Unit
HW_Rev	BMS System Hardware revision	integer
Firmware_Rev	BMS System Firmware revision	integer
Sys_Rated_Energy	Energy of entire system at BOL	kWh
Battery_String_Count	LV or HV strings in parallel, nominal value: 4	strings in parallel
Module_Count_Per_String	LV nominal value: 16 HV nominal value: 1	modules in series
Stack_Count_Per_Module	Nominal value: 12	stacks
Sys_Contactors_Populated	1: Present 0: Not available Bit 0: Positive contactor Bit 1: Negative contactor Bit 2: Positive pre-charge contactor Bit 3: Estop (Fault) relay	bitfield
Sys_Contactors_Status	1: On (closed) 0: Off (open) Bit 0: Positive contactor Bit 1: Negative contactor Bit 2: Positive pre-charge contactor Bit 3: Estop (Fault) relay	bitfield
Strings_Contactors_Status	1: On (closed) 0: Off (open) Bits 15–0: Stacks 16–1. Bit value is logical AND of all participating module contactors and participating string-level contactors in that string.	bitfield
Sys_Fault_Code	Logical OR of string fault codes	bitfield
Sys_Warning_Code	Logical OR of string warning codes	bitfield

Name	Description	Unit
Sys_SOC	Average across all usable battery strings (-50%–150%)	percentage
Sys_SOH	Average across all usable battery strings (0%–150%)	percentage
Sys_DC_Volts	Average across all usable battery strings (average of the sums of Module volts in string)	Vdc
Sys_DC_Current	Total across all usable battery strings	amps DC
Sys_Charge_Current_Limit	Total across all usable battery strings	amps DC
Sys_Discharge_Current_Limit	Total across all usable battery strings	amps DC
Sys_Charge_Power_Limit	Total across all usable battery strings	kW
Sys_Discharge_Power_Limit	Total across all usable battery strings	kW
Sys_Max_Module_Volts	LV typical range (0–60 Vdc) HV typical range (0–720 Vdc)	Vdc
Sys_Max_Module_Volts_Location	Bits 12–8: String number (1-based) Bits 4–0: Module number (1-based)	integer
Sys_Min_Module_Volts	LV typical range (0–60 Vdc) HV typical range (0–720 Vdc)	Vdc
Sys_Min_Module_Volts_Location	Bits 12–8: String number (1-based) Bits 4–0: Module number (1-based)	integer
Sys_Max_Module_Temp	Typical range -100–600 (i.e., -10°C–60°C)	degrees Celsius
Sys_Max_Module_Temp_Location	Bits 12–8: String number (1-based) Bits 4–0: Module number (1-based)	integer
Sys_Min_Module_Temp	Typical range -100–600 (i.e., -10°C–60°C)	degrees Celsius
Sys_Min_Module_Temp_Location	Bits 12–8: String number (1-based) Bits 4–0: Module number (1-based)	integer
Sys_AHR_Charge_MSB	Cumulative count of charging amp-hours since reset upper bytes	amp-hours
Sys_AHR_Charge_LSB	Cumulative count of charging amp-hours since reset lower bytes	amp-hours

Name	Description	Unit
Sys_AHR_Discharge_MSB	Cumulative count of discharging amp-hours since reset upper bytes	amp-hours
Sys_AHR_Discharge_LSB	Cumulative count of discharging amp-hours since reset lower bytes	amp-hours
Sys_KWHR_Charge_MSB	Cumulative count of charging kilowatt-hours since reset upper bytes	kWh
Sys_KWHR_Charge_LSB	Cumulative count of charging kilowatt-hours since reset lower bytes	kWh
Sys_KWHR_Discharge_MSB	Cumulative count of discharging kilowatt-hours since reset upper bytes	kWh
Sys_KWHR_Discharge_LSB	Cumulative count of discharging kilowatt-hours since reset lower bytes	kWh

C.1.2 String Level

These are the values on each string. There will be four of these data sets for a string of four.

Name	Description	Unit
String_Fault_Code	Added together... 0: No fault 1: String comms fault (bit 0) 2: Module comms fault (bit 1) 4: Module ground fault (bit 2) 8: Module out of balance (bit 3) 16: Module over voltage (bit 4) 32: Module under voltage (bit 5) 64: Module over temperature (bit 6) 128: Module under temperature (bit 7) 256: String over current (bit 8) 512: String DC contactor fault (bit 9) 1024: String fuse fault (not implemented) (bit 10)	bitfield
String_Warning_Code	Same as String_Fault_Code, but just in the warning zone	bitfield
Is_String_Available	1: Yes 0: No	Boolean

Name	Description	Unit
Is_String_Contactor_Populated	1:Yes 0: No Bit 0: Positive contactor Bit 1: Negative contactor Bit 2: Positive pre-charge contactor	bitfield
Is_String_Participating	1: Yes 0: No	Boolean
String_Modules_Populated	1: Yes 0: No Bit 0: Module 1 . Bit 15: Module 16	bitfield
String_Contactors_Status	1: On (closed) 0: Off (open) Bit 0: Positive contactor Bit 1: Negative contactor Bit 2: Positive pre-charge contactor	bitfield
String_Module_Contactors_Status	1: On (closed) 0: Off (open) Bit 0: Module 1 . Bit 15: Module 16	bitfield
String_SOC	Average across all Modules in string	percentage
String_SOH	Average across all Modules in string	percentage
String_DC_Volts	Sum of all Module voltages in string	Vdc
String_DC_Current	Average across all Modules in string	amps DC
String_Charge_Current_Limit	Maximum allowable charging current	amps DC
String_Discharge_Current_Limit	Minumum allowable discharging current	amps DC
String_Charge_Power_Limit	Maximum allowable charging power	kW
String_Discharge_Power_Limit	Minumum allowable discharging power	kW
Max_Module_Volts	Maximum allowable Module voltage	Vdc
Max_Module_Volts_Location	Bits 4–0: Module number (1-based)	integer
Min_Module_Volts	Minimum allowable Module voltage	Vdc

Name	Description	Unit
Min_Module_Volts_Location	Bits 4–0: Module number (1-based)	integer
Max_Module_Temp	Typical range -100–600 (i.e., -10°C–60°C)	degrees Celsius
Max_Module_Temp_Location	Bits 5–4: Sensor number Bits 4–0: Module number	bitfield
Min_Module_Temp	Typical range -100–600 (i.e., -10°C–60°C)	degrees Celsius
Min_Module_Temp_Location	Bits 5–4: Sensor number Bits 4–0: Module number	bitfield

C.1.3 Module Level

These are the values recorded on every module. A system with N strings and M modules per string will have M × N of these data sets.

Name	Description	Unit
Status_Code	TBD	bitfield
Fault_Code	0: No fault 1: Reset initialization state 2: Module comms fault 3: Module ground fault 4: Module out of balance 5: Module over voltage 6: Module under voltage 7: Module over temperature 8: Module under temperature 9: Module over current 10: Module DC contactor fault 11: Module fuse fault (not implemented) 12: Stack over current	bitfield
Warning_Code	Same as fault codes but just a warning	bitfield
Module_Voltage	Sum of all Stack voltages	Vdc
Module_Current	Sum of all Stack currents if LV; average of all Stack currents if HV	amps DC
Module_Temperature	Average of temperature sensors	degrees Celsius
Stack1_Voltage	—	Vdc
Stack2_Voltage	—	Vdc

Name	Description	Unit
Stack3_Voltage	—	Vdc
Stack4_Voltage	—	Vdc
Stack5_Voltage	—	Vdc
Stack6_Voltage	—	Vdc
Stack7_Voltage	—	Vdc
Stack8_Voltage	—	Vdc
Stack9_Voltage	—	Vdc
Stack10_Voltage	—	Vdc
Stack11_Voltage	—	Vdc
Stack12_Voltage	—	Vdc
Stack1_Current	Stack 1 current	amps DC
Stack2_Current	Stack 2 current	amps DC
Stack3_Current	Stack 3 current	amps DC
Stack4_Current	Stack 4 current	amps DC
Stack5_Current	Stack 5 current	amps DC
Stack6_Current	Stack 6 current	amps DC
Stack7_Current	Stack 7 current	amps DC
Stack8_Current	Stack 8 current	amps DC
Stack9_Current	Stack 9 current	amps DC
Stack10_Current	Stack 10 current	amps DC
Stack11_Current	Stack 11 current	amps DC
Stack12_Current	Stack 12 current	amps DC
Temp_Sensor_Upper	Module temperature sensor number 1	degrees Celsius
Temp_Sensor_Lower	Module temperature sensor number 2	degrees Celsius
Temp_Sensor_PCB	Circuitboard temperature sensor	degrees Celsius
Positive_to_Ground_Voltage	Measured from positive bus bar to earth ground (0: unused)	Vdc

Name	Description	Unit
DigOutputs_Status	1: On (closed) 0: Off (open) Bit 0: Positive contactor Bit 1: Negative contactor Bit 2: Third output	bitfield
Inputs_Status	1: Asserted 0: Missing or unasserted Bits 2–0: Input bits	bitfield
Module_SOC	Module state of charge	percentage
Module_SOH	Module state of health	percentage
Module_SerialNumber	Lowest 16 bits of 64-bit hardware serial number	integer
Module_PCA_Number	Aquion-given PCA serial number	integer
Module_FW_Version	Version of the firmware currently running on the BMS	integer
Cycle_Counter	Number of times the system has been cycled	integer
Fault_Counter	Number of times a fault has been triggered	integer
OverVolt_Event_Counter	Number of times the Module has exceeded the over-voltage limit	integer
OverTemp_Event_Counter	Number of times the Module has exceeded the over-temperature limit	integer
Module_Type	1: LV module with LV VIS 2: HV module with HV VIS	integer

C.2 CSV Data

CSV data is an abridged version of the binary log data. This allows the files to be much smaller and stored for much longer time periods.

Name	Description	Units
HW_Rev	BMS System Hardware revision	integer
Firmware_Rev	BMS System Firmware revision	integer
Sys_Rated_Energy	Energy of entire system at BOL	kWh

Name	Description	Units
Battery_String_Count	LV or HV strings in parallel, nominal value: 4	strings in parallel
Module_Count_Per_String	LV nominal value: 16 HV nominal value: 1	modules in series
Stack_Count_Per_Module	Nominal value: 12	stacks
Sys_SOC	Average across all usable battery strings (-50%–150%)	percentage
Sys_SOH	Average across all usable battery strings (0%–150%)	percentage
Sys_DC_Volts	Average across all usable battery strings (average of the sums of Module volts in string)	Vdc
Sys_DC_Current	Total across all usable battery strings	amps DC
Sys_Charge_Current_Limit	Total across all usable battery strings	amps DC
Sys_Discharge_Current_Limit	Total across all usable battery strings	amps DC
Sys_Charge_Power_Limit	Total across all usable battery strings	kW
Sys_Discharge_Power_Limit	Total across all usable battery strings	kW
Sys_Max_Module_Volts	LV typical range (0–60 Vdc) HV typical range (0–720 Vdc)	Vdc
Sys_Max_Module_Volts_Location	Bits 12–8: String number (1-based) Bits 4–0: Module number (1-based)	integer
Sys_Min_Module_Volts	LV typical range (0–60 Vdc) HV typical range (0–720 Vdc)	Vdc
Sys_Min_Module_Volts_Location	Bits 12–8: String number (1-based) Bits 4–0: Module number (1-based)	integer
Sys_Max_Module_Temp	Typical range -100–600 (i.e., -10°C–60°C)	degrees Celsius
Sys_Max_Module_Temp_Location	Bits 12–8: String number (1-based) Bits 4–0: Module number (1-based)	integer
Sys_Min_Module_Temp	Typical range -100–600 (i.e., -10°C–60°C)	degrees Celsius
Sys_Min_Module_Temp_Location	Bits 12–8: String number (1-based) Bits 4–0: Module number (1-based)	integer

Name	Description	Units
Sys_AHR_Charge_MSB	Cumulative count of charging amp-hours since reset upper bytes	amp-hours
Sys_AHR_Charge_LSB	Cumulative count of charging amp-hours since reset lower bytes	amp-hours
Sys_AHR_Discharge_MSB	Cumulative count of discharging amp-hours since reset upper bytes	amp-hours
Sys_AHR_Discharge_LSB	Cumulative count of discharging amp-hours since reset lower bytes	amp-hours
Sys_KWHR_Charge_MSB	Cumulative count of charging kilowatt-hours since reset upper bytes	kWh
Sys_KWHR_Charge_LSB	Cumulative count of charging kilowatt-hours since reset lower bytes	kWh
Sys_KWHR_Discharge_MSB	Cumulative count of discharging kilowatt-hours since reset upper bytes	kWh
Sys_KWHR_Discharge_LSB	Cumulative count of discharging kilowatt-hours since reset lower bytes	kWh

C.3 Log Files

Log files keep track of operations that occur on the system such as when faults occur or data logging is started.